III. CLAIM AMENDMENTS

Please amend claims 1, 6, 17 and 35, and add new claims 36-39 as set forth in the following listing of the claims.

1. (Currently Amended) A thin film resonator structure (1200, 1300, 1400), where a certain wave mode is piezoelectrically excitable and which resonator structure comprises at least two conductor layers (110, 120) and at least one piezoelectric layer (100) in between the conductor layers, said resonator structure having a first area over which said conductor layers and piezoelectric layer extend~~ing over a first area of the resonator structure~~, which first area is a piezoelectrically excitable area of the resonator structure, **characterized in that**

the resonator structure comprises a frame-like zone (2, 4) of any shape which frame-like zone confines ~~confinsing~~ a center area (3) within the first area of the resonator structure,

~~the center area is within the first area of the resonator structure,~~

a cut-off frequency of the piezoelectrically excited wave mode in the layer structure of the frame-like zone is different from the cut-off frequency of the piezoelectrically excited wave mode in the layer structure of the center area, and

a width of the frame-like zone and acoustical properties of the layer structure in the frame-like zone are arranged so

that displacement relating to the piezoelectrically excited strongest resonance mode is substantially uniform in the center area of the resonator.

2. (Original) A resonator structure according to claim 1, **characterized** in that the width of the frame-like zone is not uniform.

3. (Original) A resonator structure according to claim 1, **characterized** in that the cross-section of the frame-like zone is not uniform.

4. (Original) A resonator structure according to claim 1, **characterized** in that the frame-like zone has a substantially uniform width.

5. (Original) A resonator structure according to claim 4, **characterized** in that the cross-section of the frame-like zone is substantially rectangular.

6. (Currently Amended)A resonator structure according to claim 4, **characterized** in that the width of the frame-like zone and the cut-off frequency in the layer structure of the frame-like zone are arranged so that a lateral resonance frequency in a ~~infinitely long~~ rectangular resonator, whose width is twice the width of the frame-like zone, where the cut-off frequency is the same as the cut-off frequency in the layer structure in the frame-like zone and which is surrounded by the layer structure

of the area surrounding the frame-like zone, is substantially the same as the cut-off frequency in the center area.

7. (Original) A resonator structure (1230) according to claim 1, **characterized** in that the frame-like zone is substantially circular.

8. (Original) A resonator structure (1220) according to claim 1, **characterized** in that the frame-like zone is substantially polygonal.

9. (Original) A resonator structure (1210) according to claim 8, **characterized** in that the frame-like zone is substantially rectangular.

10. (Original) A resonator structure according to claim 9, **characterized** in that the cross-section of the frame-like zone is substantially rectangular.

11. (Original) A resonator structure (820, 840, 850) according to claim 1, **characterized** in that the cut-off frequency of the piezoelectrically excited wave mode in the layer structure of the frame-like zone is higher than the cut-off frequency of the piezoelectrically excited wave mode in the layer structure of the center area.

12. (Original) A resonator structure according to claim 11, **characterized** in that the dispersion of the piezoelectrically excited wave mode is of type II in the frame-like area.

13. (Original) A resonator structure (810, 830, 860) according to claim 1, **characterized** in that the cut-off frequency of the piezoelectrically excited wave mode in the layer structure of the frame-like zone is lower than the cut-off frequency of the piezoelectrically excited wave mode in the layer structure of the center area.

14. (Original) A resonator structure according to claim 13, **characterized** in that the dispersion of the piezoelectrically excited wave mode is of type I in the frame-like area.

15. (Original) A resonator structure (1000, 1300, 1700, 1820) according to claim 1, **characterized** in that the frame-like zone is within the first area.

16. (Original) A resonator structure according to claim 1, **characterized** in that the frame-like zone is at least partly outside the first area.

17. (Currently Amended) A resonator structure (1810, 1820) according to claim 1, **characterized** in that at least one of the layers of the resonator has a first part, which is patterned by variation in thickness, and a second part~~, which consists of is a~~ of uniform thickness ~~thin film~~.

18. (Original) A resonator structure (1810) according to claim 17, **characterized** in that the first part is a rim covering the frame-like zone.

19. (Original) A resonator structure according to claim 18, **characterized** in that the layer having the first part and the second part is a top electrode of the resonator structure.

20. (Original) A resonator structure (1820) according to claim 17, **characterized** in that the second part covers the frame-like zone.

21. (Original) A resonator structure according to claim 20, **characterized** in that the layer having the first part and the second part is a passivation layer of the resonator structure.

22. (Original) A resonator structure (1710) according to claim 1, **characterized** in that

the thickness of the center area is substantially uniform,

the thickness of a region surrounding the frame-like zone is substantially uniform at a certain region next to an interface between the frame-like zone and the surrounding region, and

the thickness of the frame-like zone varies over the width of the frame-like zone.

23. (Original) A resonator structure according to claim 22, **characterized** in that the frame-like zone is thicker at an interface between the center area and the frame-like zone than at the interface between the frame-like zone and the surrounding material.

24. (Original) A resonator structure according to claim 22, **characterized** in that the frame-like zone is thinner at the interface between the center area and the frame-like zone than at the interface between the frame-like zone and the surrounding material.

25. (Original) A resonator structure (1400) according to claim 1, **characterized** in that in the frame-like zone a first layer (120) extending at least over the center area and the frame-like zone overlaps with a second layer (140) extending over the frame-like zone and over some part of the area surrounding the frame-like zone.

26. (Original) A resonator structure according to claim 25, **characterized** in that the first layer is one of the conductor layers and the second layer is a passivation layer.

27. (Original) A resonator structure (1300) according to claim 1, **characterized** in that it comprises at least one frame-like layer, which forms the frame-like zone.

28. (Original) A resonator structure (1000) according to claim 1, **characterized** in that the frame-like zone is arranged by varying the thickness of at least one of the layers extending at least over the frame-like zone and the center area, so that the thickness of said layer is different in the frame-like zone than in the center area.

29. (Original) A resonator structure according to claim 28, **characterized** in that said layer is a top electrode (120) of the resonator structure.

30. (Original) A resonator structure according to claim 28, **characterized** in that said layer is thicker in the frame-like zone than in the center area.

31. (Original) A resonator structure according to claim 28, **characterized** in that said layer is thinner in the frame-like zone than in the center area.

32. (Original) A resonator structure according to claim 1, **characterized** in that it is a thin film bulk acoustic wave resonator.

33. (Original) A resonator structure according to claim 1, **characterized** in that the thickness of the resonator structure in the center area is substantially uniform.

34. (Original) A resonator structure according to claim 1, **characterized** in that the thickness of the resonator in the center area is different in a first part of the center area than in a second part in the center area.

35. (Currently Amended) A filter comprising at least one thin film resonator structure (1200, 1300, 1400), where a certain wave mode is piezoelectrically excitable and which resonator structure comprises at least two conductor layers (110, 120) and at least one piezoelectric layer (100) in between the conductor layers, said resonator structure having a first area over which said conductor layers and piezoelectric layer extend ~~extending over a first area of the resonator structure~~, which first area is a piezoelectrically excitable area of the resonator structure, **characterized** in that

the resonator structure comprises a frame-like zone (2, 4) of any shape which frame-like zone confines ~~confining~~ a center area (3) within the first area of the resonator structure,

~~the center area is within the first area of the resonator structure,~~

a cut-off frequency of the piezoelectrically excited wave mode in the layer structure of the frame-like zone is different from the cut-off frequency of the piezoelectrically excited wave mode in the layer structure of the center area, and

a width of the frame-like zone and acoustical properties of the layer structure in the frame-like zone are arranged so that displacement relating to the piezoelectrically excited strongest resonance mode is substantially uniform in the center area of the resonator.

36. (New) A filter according to claim 35 wherein the resonator structure comprises at least four layers that includes at least two piezoelectric layers.

37. (New) A filter according to claim 36 wherein each of said two conductor layers and each of said two piezoelectric layers is a thin film.

38. (New) A resonator structure according to claim 1 wherein the resonator structure comprises at least four layers that includes at least two piezoelectric layers.

39. (New) A resonator structure according to claim 38 wherein each of said two conductor layers and each of said two piezoelectric layers is a thin film.

IV. REMARKS

In the office action, claims 6 and 17-21 were rejected under 35 U.S.C. 112 as being indefinite for reasons set forth in the Action. Claim 1, 3, 7, 11-16, 22, 24, 27 and 33-35 were rejected under 35 U.S.C. 102 as being anticipated by Hirama (US 6,111,341), and claims 8-10, 17-21, 23, 25, 26 and 28-32 were rejected under 35 U.S.C. 103 as being unpatentable over Hirama for reasons set forth in the Action. It is noted that the Action is silent with respect to whether claims 2, 4, 5 and 6 are rejected on prior art or whether they contain allowable subject matter.

With respect to the rejections under 35 U.S.C. 112, claim 6 has been amended by changing the "infinitely long rectangular resonator" to "a rectangular resonator". The amended terminology is believed to be adequately clear in view of the discussion of cut-off frequency and resonator characteristics presented in the present specification (page 4 at lines 27 to 31, page 7 at lines 2 to 5, page 11 at lines 8 to 17, and page 29 at lines 12 to 36.

Claim 17 has been amended for clarity, thereby to overcome the rejection of claim 17 and its dependent claims 18-21 under 35 U.S.C. 112. In amended claim 17, the description of the patterned first part has been amplified by stating that the pattern is obtained by variation in thickness as disclosed in present Fig. 18 and the accompanying text of the specification at the bottom paragraph of page 29, particularly the last sentence at lines 34-36 and which there is a variation of thickness. By way of example, as shown in Fig. 18a, one of the

layers, namely the top electrode 120, is provided with patterning obtained by a 100 percent variation in its thickness to produce a succession of islands in the patterned region. The remaining region of the right side of the electrode 120 is not patterned and is characterized by uniform thickness. The term "uniform thickness" is employed in the amendment of Claim 17 to state that the second part is of uniform thickness.

In order to distinguish the present claims from the teachings of the cited art, thereby to overcome the rejections under 35 U.S.C. 102 and 103, the independent claims 1 and 35 have been amended. The amended claims 1 and 35 specifically recite that the resonator structure of the present convention is a thin film resonator, this finding support in the present specification (page 8, lines 19 to 21). The claims 1 and 35 are amended also to clarify that the frame-like zone can be of any shape, and is not restricted to the circular shape disclosed by Hirama. In addition, the wording of the preamble of claims 1 and 35 is amended to define more clearly that the first area is that area over which the conducting layers and the piezoelectric layer extend.

The present invention is distinguishable from the teaching of Hirama. Hirama teaches a circular type AT-cut quartz resonator substrate (column 4 at lines 6 to 10, figures 1-2 and 11-22, claim 1) which constitutes a macroscopic resonator with a single crystal piezoelectric structure. Also the equations and methods disclosed by Hirama do not provide any means for designing structures of shape other than circular. The present invention can be practiced with any shape of a frame-like zone (and resonator structure as well), and is not restricted to circular

resonators with raised rim area as is the Hirama teaching. The frame-like zone according to the present invention can be round, rectangular, irregular, polygon or other shape as shown in figures 12a to 12d and on page 8 lines 6 to 9. The capability to design and use resonators of any shape according to the present invention has important practical implications. The circular shape is disadvantageous because of poorer packaging density of multiple resonators in a single chip, i.e. filters consisting of multiple resonators.

The AT-cut quartz resonator taught by Hirama has fundamental differences in properties compared to the thin film resonator structure of the present invention. The object of Hirama is to provide the AT-cut quartz resonator to reduce the capacitance ratio by using inverted-mesa electrodes (column 1 line 63 to column 2 line 2). The capacitance ratio is determined by the material constants. In Hirama, the reported reduction of capacitance ratio from 200 to 169 (column 4 lines 58 to 59) or even 156 (column 10 lines 5 to 10) does not apply to the thin film resonator structures of the present invention. The capacitance ratio is in a range of 30 to 10 and remains unchanged independently of any shape or structure used at the edge of active area in thin film resonator structures of the present invention, even without any kind of "inverted mesa" structure proposed by Hirama. This means that the object of the present invention differs from those disclosed by Hirama.

The object of the present invention for is to provide the resonator structure wherein the piezoelectrically excited strongest resonance mode is the most appropriate mode, and the displacement of particles is uniform (page 7 lines 20 to 22). The fundamental difference between the present invention and

Hirama is that the resonator (vibrator) and all the equations disclosed by Hirama refer to a shear horizontal (SH) mode of operation (column 5 line 8), while the resonator structure of the present invention operates in the longitudinal mode, namely the thickness extentional (TE) mode (present specification, page 7 lines 22 to 25). In the piston mode (TE mode) the displacement is uniform in the center area of the resonator (present specification, page 7 at lines 27 to 31). This means that the acoustic mode of operation is different in Hirama and in the present invention.

The resonator structure taught by Hirama only applies to three layers, namely two electrodes and one piezoelectric layer. The thin film resonator structures based on polycrystalline piezoelectric layer according to the present invention have at least four different material layers, often as many as ten layers. In other words the present invention applies to various numbers and combinations of layers and shapes. New claims 36 and 38 emphasize that the present invention may have a four-layer (or more layers) structure to distinguish over the teaching of Hirama. New claims 37 and 39 emphasize that each of the two conductor layers and each of the two piezoelectric layers is a thin film.

The method of calculating the cut-off frequencies by Hirama only works for the macroscopic resonators, such as AT-cut quartz resonators, where the relative thickness of the electrodes is vanishing small compared to the piezoelectric layer. Hirama teaches structures for piezoelectric layers where a layer is two orders of magnitude thicker than used in the thin-film structure of the present invention, which operates e.g. at 1GHz. Because the thin film resonator structures are always multilayer

structures, the dispersion characteristics of the complete resonator are influenced by all the layers present in the stack of leaders and, therefore, the equations and method disclosed by Hirama are not suitable for designing the thin film structures of the present invention. The single cut-off frequency of the piezoelectrically excited wave mode, which describes the dispersion characteristics of the present invention, is valid for all regions I to III with different cut-off frequencies in Hirama. Also manufacturing processes for thin film resonators are totally different from manufacturing processes for macroscopic resonators with electrode patterning and etching tolerances disclosed by Hirama.

The foregoing analysis shows that a knowledge of the teaching of Hirama would not enable one to practice the present invention nor motivate one to practice the present invention. Accordingly, it is believed that the present amendment and argument have overcome the rejections under 35 U.S.C. 102 and 103, so as to secure allowable subject matter in the claims.

For all of the foregoing reasons, it is respectfully submitted that all of the claims now present in the application are clearly novel and patentable over the prior art of record, and are in proper form for allowance. Accordingly, favorable reconsideration and allowance is respectfully requested. Should any unresolved issues remain, the Examiner is invited to call Applicants' attorney at the telephone number indicated below.

A check in the amount of $182.00 is enclosed for a one month extension of time and additional claim fees. The Commissioner is hereby authorized to charge payment for any fees associated

with this communication or credit any over payment to Deposit Account No. 16-1350.

Respectfully submitted,

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